Are Quasars Physically Associated with Nearby Galaxies? (NO!)

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Critical Examinations of QSO's Redshift Periodicities and Associations with Galaxies in Sloan Digital Sky Survey Data

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Outlines

- Non-cosmological redshift and ejection hypothesis:

  QSOs are non-cosmological objects. They are ejected by, and *physically associated with nearby galaxies* with unknown *intrinsic periodic redshift*

  Karlsson formula: periodicity in log*(1+z)* (Karlsson 1977, 1990; Arp et al. 1990, 2005; Burbidge & Napier 2001, 2003 etc.)

  Decreasing intrinsic redshift (DIR) model: periodicity in *z* (Bell 2004)

- Critical examination using SDSS and 2dF data:

  No periodicity in **log(1+z)**

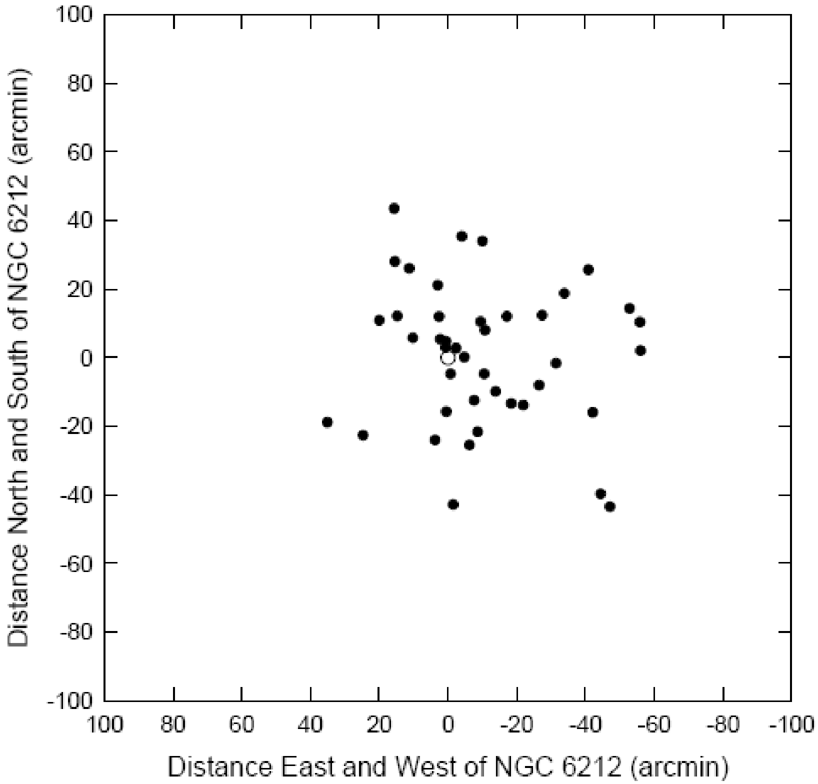
  No periodicity in z

  No strong connection between active galaxies and high-z QSOs

- Discussion and conclusion

Clustering of QSOs around nearby galaxies

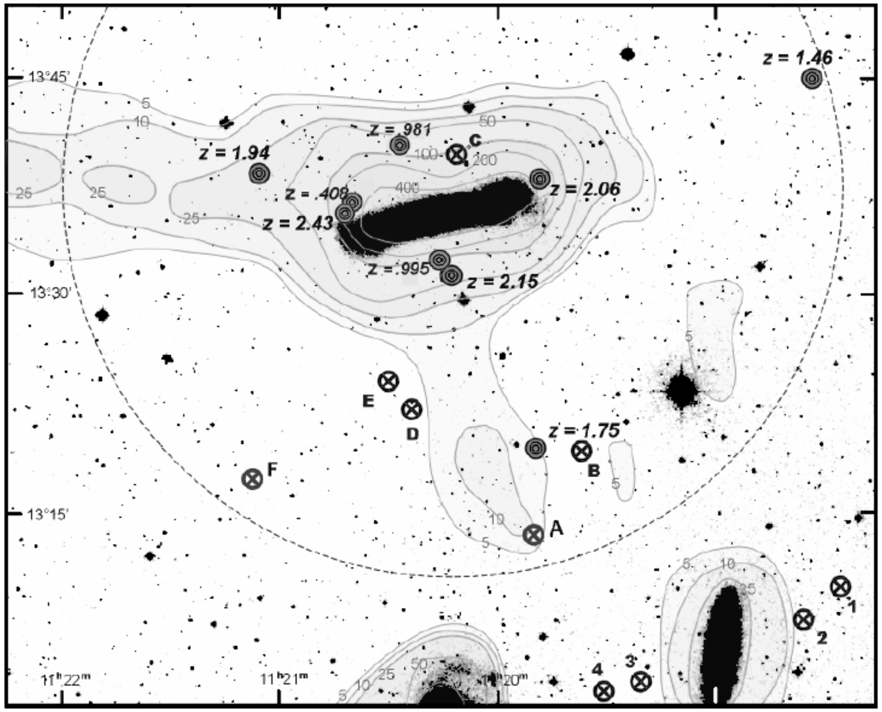
41 QSOs around NGC 6212 within 1°



9 Mpc

Burbidge 2003

7 QSOs around NGC 3628 within 15'



100 kpc

Arp et al. 2002

Preferred redshifts I: Karlsson formula

- The existence of preferred redshifts for quasars was first pointed out by Burbidge and Burbidge (1967), and the mathematical solution for the periodicity was discovered by Karlsson (1971, 1977):

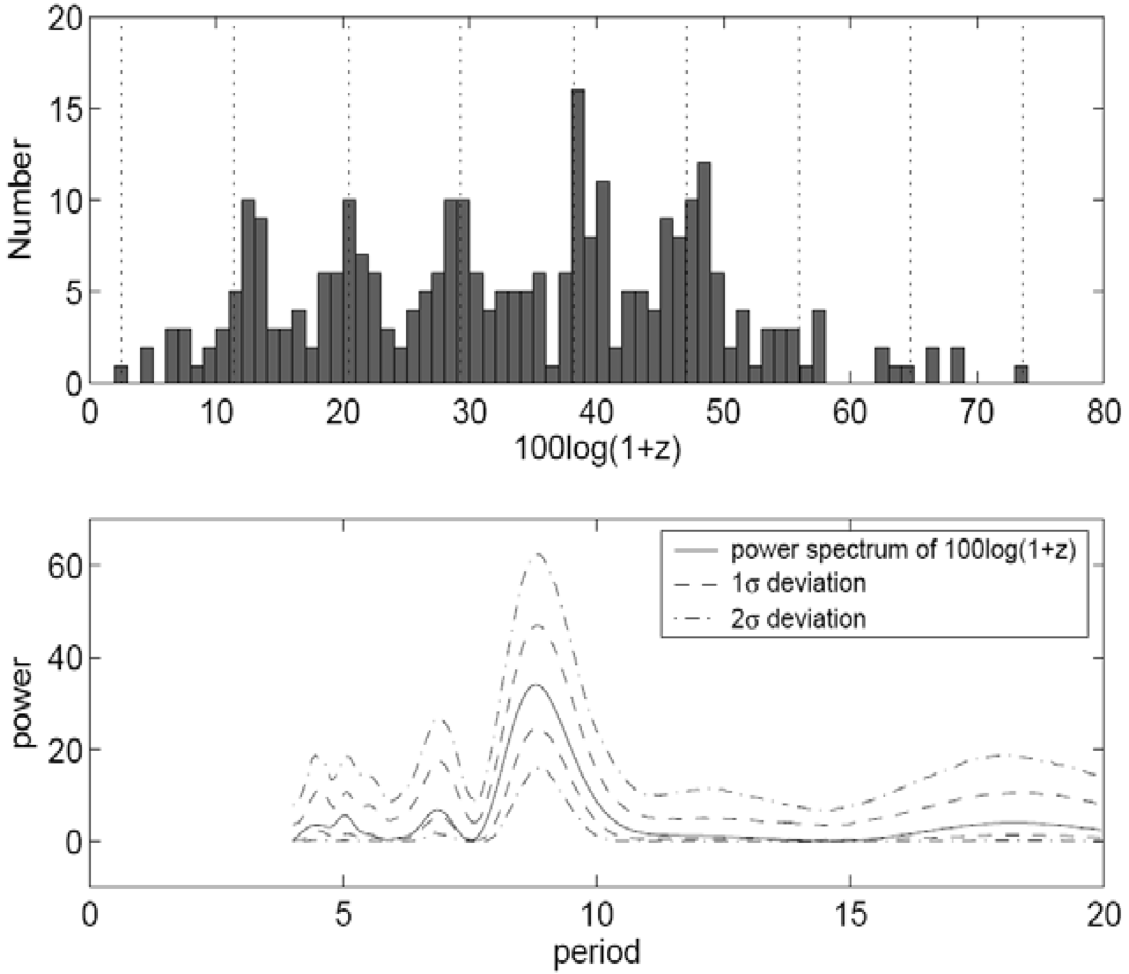
$$\triangle \log(1 + z_{eff}) = 0.089$$

where $$1 + z_{eff} = (1 + z_Q)/(1 + z_G)$$

with peaks peaks lying at z_{eff} = 0.061, 0.30, 0.60, 0.96, 1.14, 1.96 and so on.

- To explain such a periodicity, they claimed that quasars are ejected by active galaxies and the putative parent galaxies are generally much brighter than their quasar off-springs (Arp et al. 2005). As claimed by Burbidge & Napier (2001, 2003), the typical projected association separation is about 200 kpc.

Karlsson formula: periodicity in log(1+z)



116 QSOs close to low-z galaxies
57 QSOs separations less than 10”
39 X-ray QSOs close to bright active galaxies
78 3C and 3CR QSOs

Karlsson 1990
Burbidge&Napier 2001
Napier&Burbidge 2003

Preferred redshifts II: DIR model

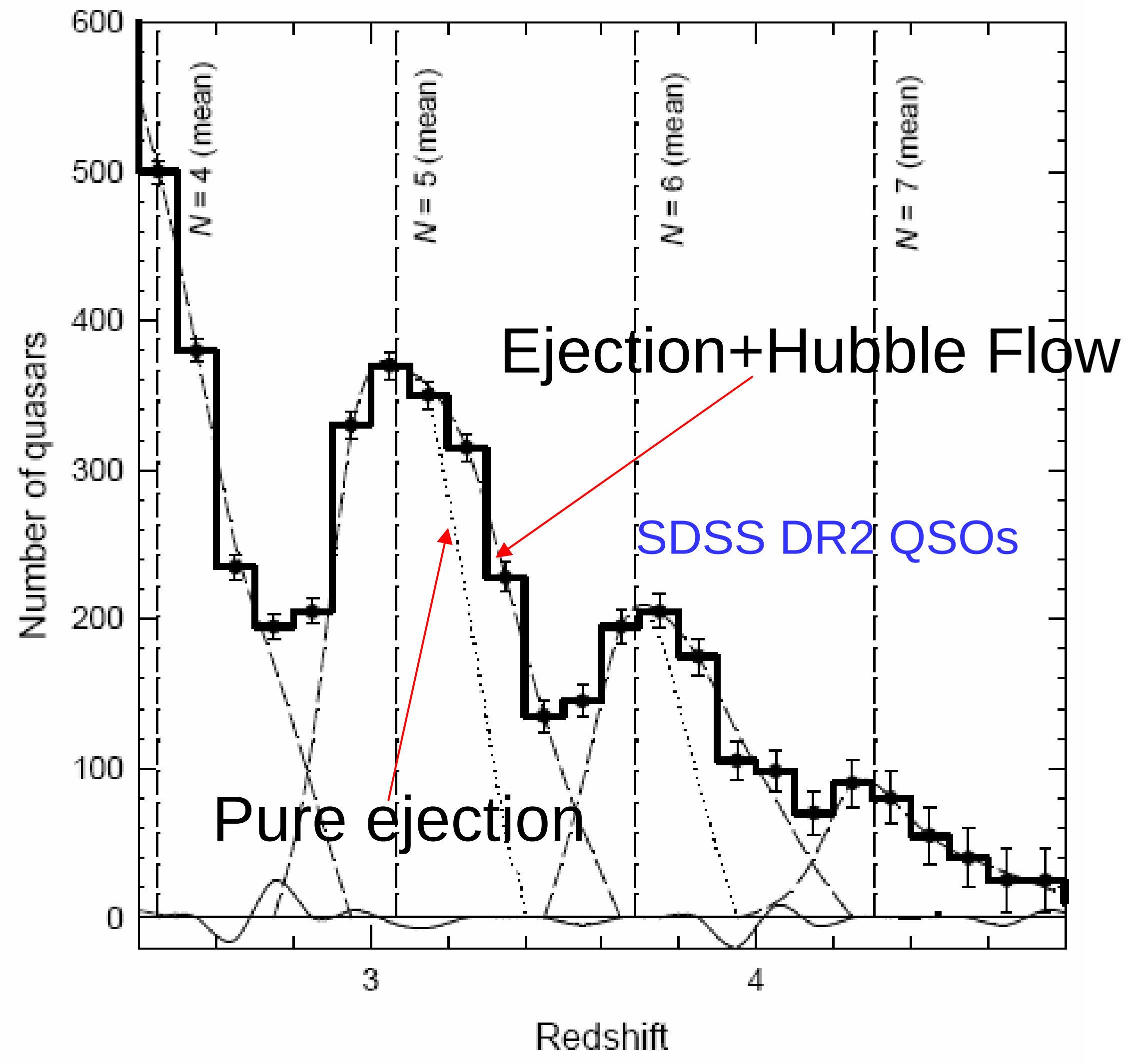
- The decreasing intrinsic redshift model (DIR model), was proposed by Bell (2004), where the QSO intrinsic redshift equation is given by the relation: $z_{iQ} = z_f\,(N - M_N)$

  where $z_f = 0.62$ is the intrinsic redshift constant, N is an integer, and M_N varies with N and is a function of second quantum number n.
- In the DIR model, galaxies are produced continuously through the entire age of the universe, and QSOs are assumed to be ejected from the nuclei of active galaxies and represent the very short lived stage (10^7 ~ 10^8 yr) in the evolution of galaxies (Bell 2004), which are also the seeds of future galaxies.

N	M_N	n	Data Source
1.......	n	0, 1, 2, 3...9	Quasars ($z < 0.6$)
2.......	$n(n+1)/2$	0, 1, 2, 3, 4, 5	QSOs near NGC 1068
3.......	$[p(p+1)/2]$[a]	0, 1, 2, 3	Extrapolated from $N = 1$ and 2
4.......	$[q(q+1)/2]$[b]	0, 1, 2	Extrapolated from $N = 1$, 2 and 3

[a] $p = n(n+1)/2$. [b] $q = p(p+1)/2$.

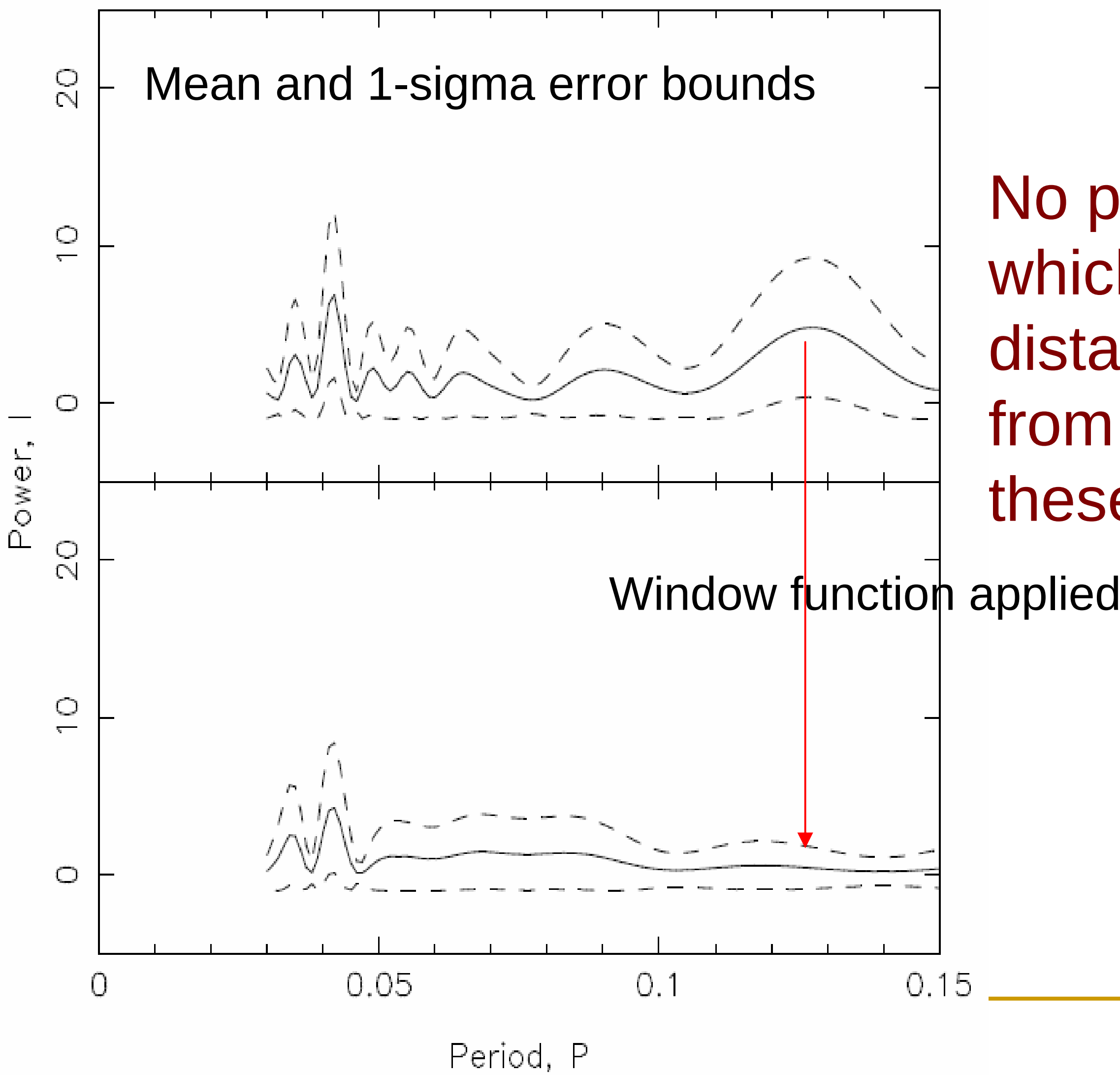
DIR model: periodicity in z



Mean ejection velocity of 11,000 km/s

Bell 2004

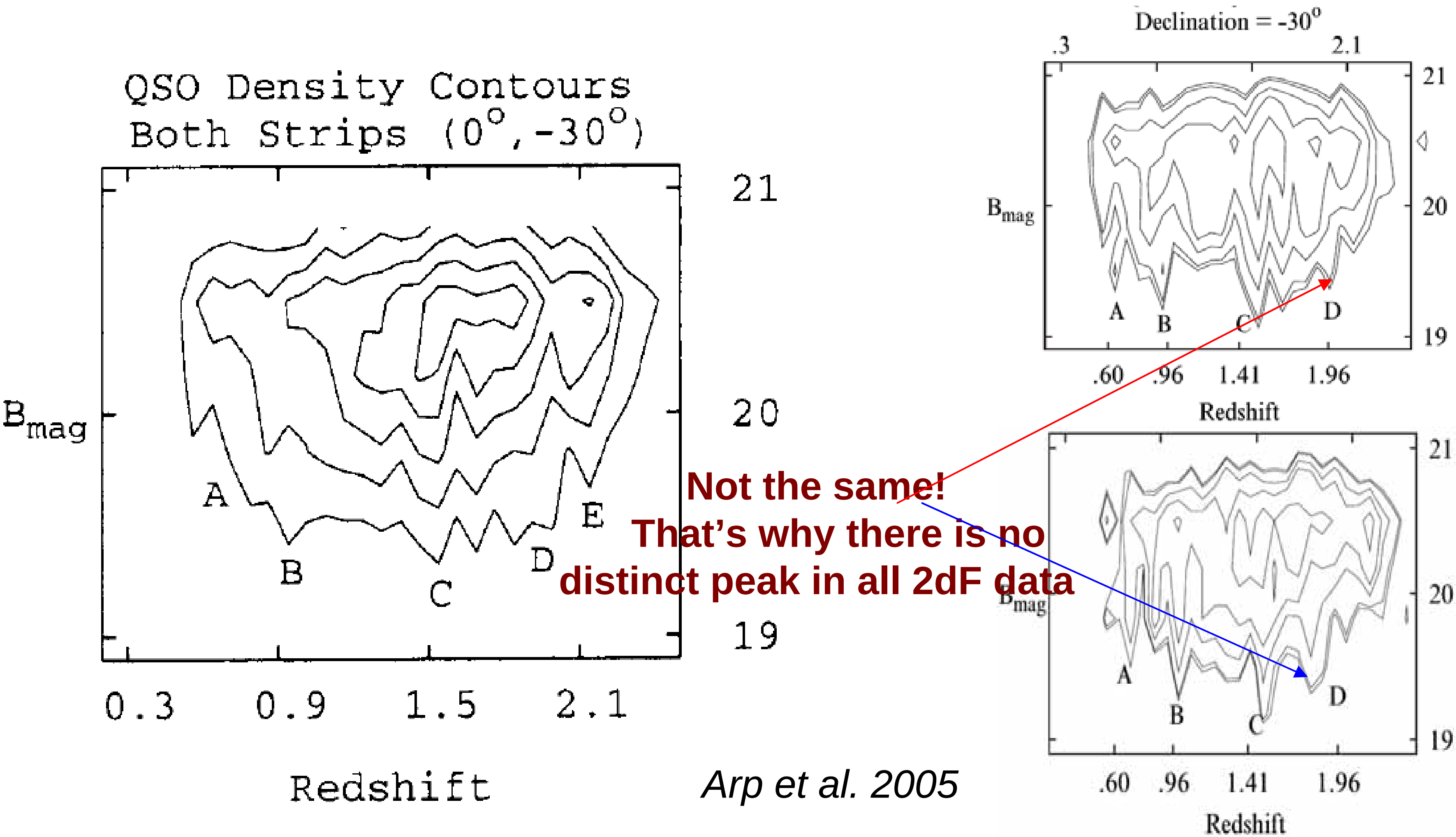
Previous objection I:
no periodicity in log(1+z) in 2dF data



No periodicity in 2dF QSOs which have projection distances less than 200 kpc from nearby galaxies at these galaxies' distances

Hawkins et al. 2002

However, periodicity in log(1+*z)* was claimed to exist in 2dF QSOs



Arp et al. 2005

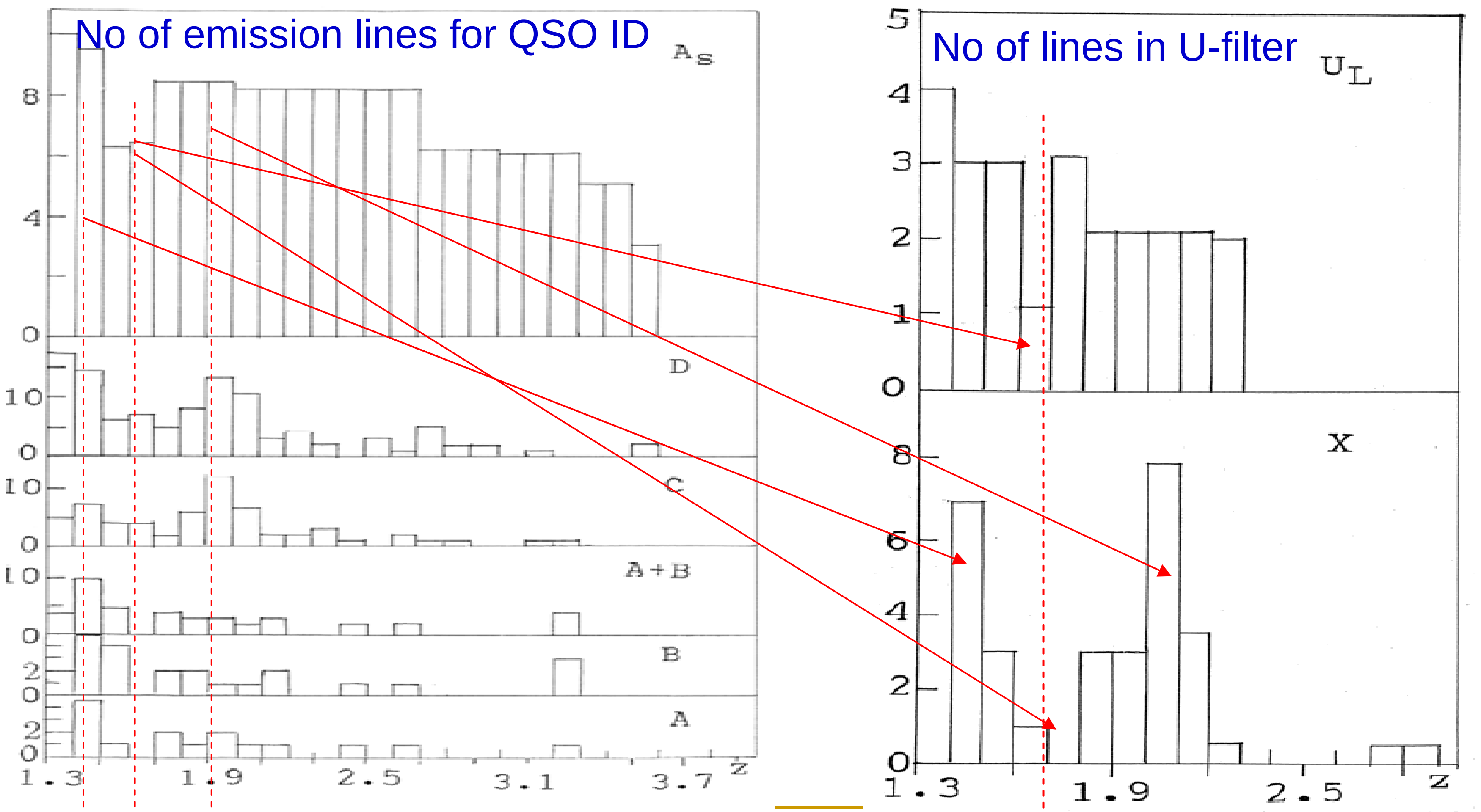
Figure 3: Apparent magnitude vs measured redshift plot for quasars in the 2dF final release (22,435 QSO's). The canonical Karlsson peaks at 0.60, 0.96, 1.41, 1.96 are indicated by their letter positions in Figs 1 and 2. An additional peak at $z \sim 2.1$ is also indicated, as noted in text

Previous objection II: selection effects in the redshift distribution

- Selection effects → observed peaks and troughs in redshift distribution of several samples (Basu 1999, 2001, 2005):
  - availability of search lines (A_S): among 23 candidate lines
  - brightness of QSOs due to the effect of emission lines (U_L): number of lines entering the U-filter resulting in bright ones more easily observed
  - changes in the observed (U-B) color ($(U\text{-}B)_L$) and (B-V) color ($(B\text{-}V)_L$): the effect of emission lines entering U, B, V filters in changing the color index of a QSO ($(U\text{-}B)_L$ and/or $(B\text{-}V)_L$ resulting in the object being mistaken as an MS star.

Previous objection II: selection effects in the redshift distribution

For periodicity found by Arp et al. 1990 and Karlsson 1990



A,B,C,D,X are different samples

Basu 1999

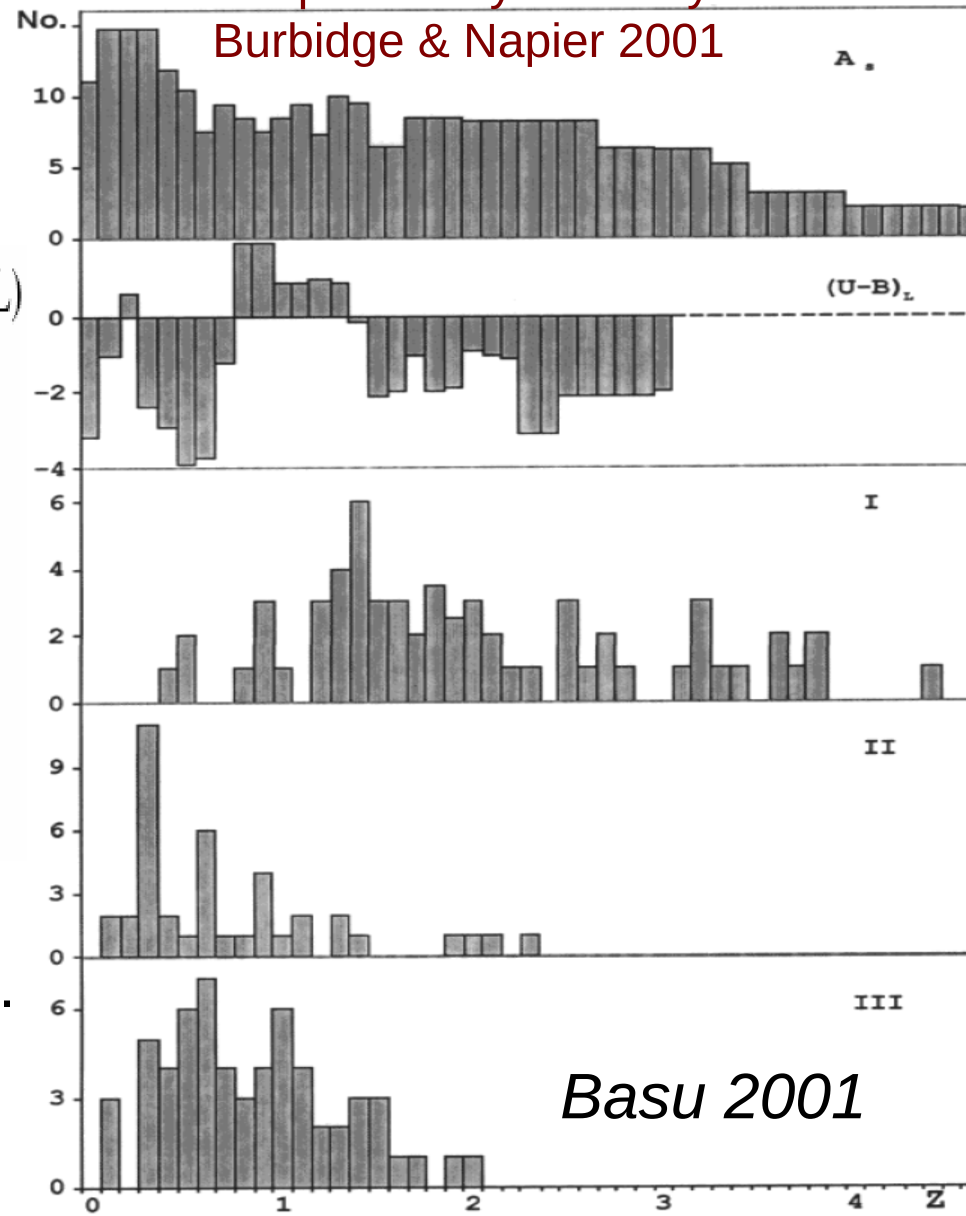
Previous objection II: selection effects in the redshift distribution

Table 1. Correlation coefficient (r) and significance level (L)

Sample	Parameter	z range	r	L [%]
I	A_s	$1.3\leq z\leq 4.5$	0.6065	>99
	$(U\text{-}B)_L$	$1.3\leq z\leq 3.1$	0.6244	>99
II	A_s	$0\leq z\leq 2.4$	0.4309	>95
III	A_s	$0\leq z\leq 2.1$	0.1776	<95
	$(U\text{-}B)_L$	$0.7\leq z\leq 2.1$	0.5661	>95

The peaks and troughs are well correlated with selection effects.

For periodicity found by Burbidge & Napier 2001



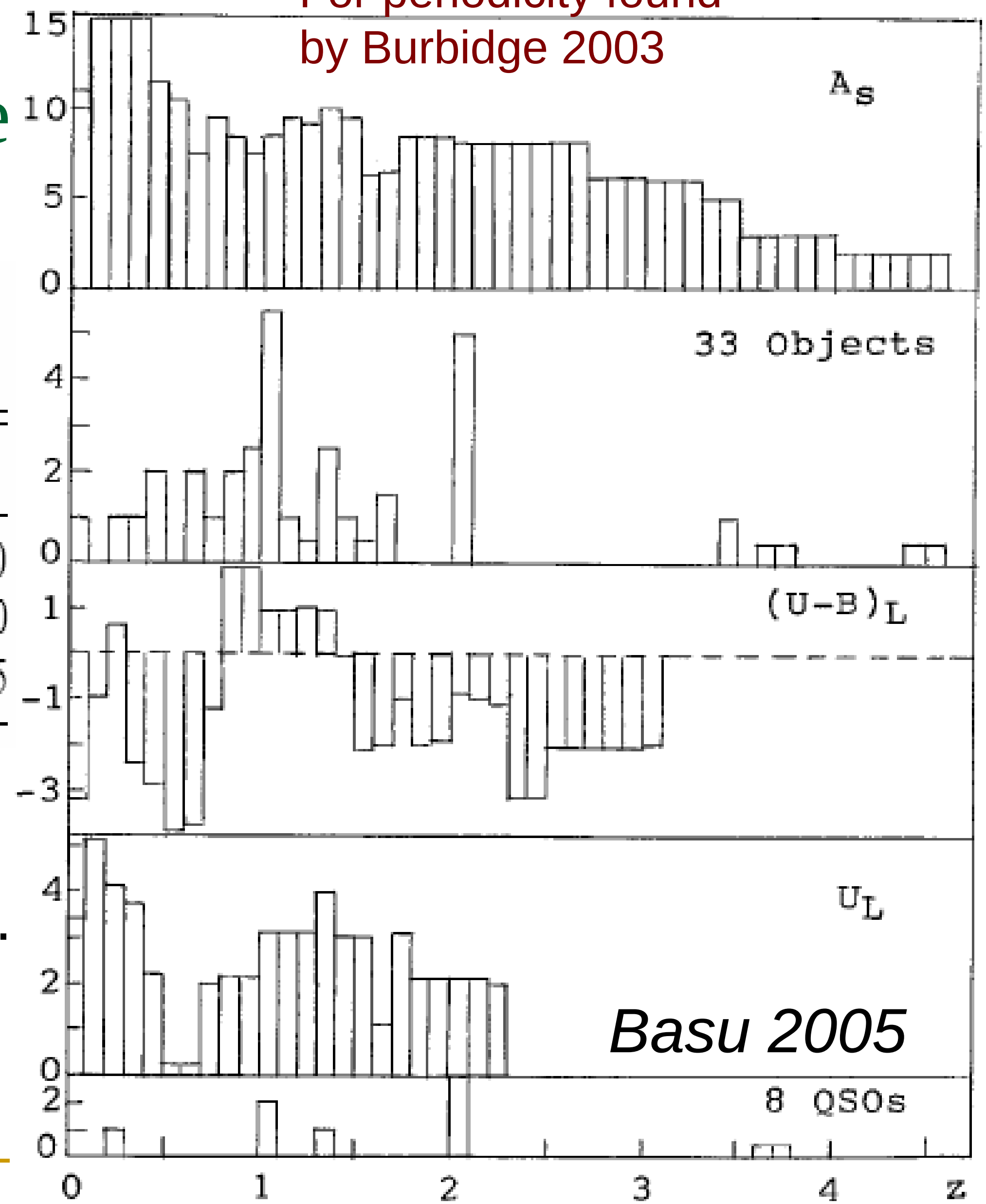
Previous objection II: selection effects in the redshift distribution

CORRELATION COEFFICIENT (r) AND PERCENTAGE SIGNIFICANCE LEVEL (L)

Sample/Parameter	Redshift range	r	L
33 objects/A_s	0–4.6	0.2566	>90
Eight QSOs/$(U-B)_L$	0–3.8	0.2650	~90
Eight QSOs/U_L	0–3.8	0.2326	~85

The peaks and troughs are well correlated with selection effects.

For periodicity found by Burbidge 2003



Our work -- No periodicity in log(1+z): the SDSS Data and Pair Selection

- QSOs: 15747 QSOs with $z > 0.4$ in SDSS DR1 QSO catalog (Schneider et al. 2003)
- Galaxies: 190591 nearby galaxies in the range of $0.01 < z < 0.2$ with the highest plate quality in the New York University Value-Added Galaxy Catalog (NYU-VAGC) (Blanton et al. 2005)
- It was claimed that quasars with bright apparent magnitude and active galaxies are more likely to be paired
  - a sub-sample of 3724 bright QSOs: with i<18.5
  - a sub-sample of 77426 active galaxies: labeled as starforming, starburst, starforming broadline or starburst broadline galaxies

Our work -- No periodicity in log(1+z): the SDSS Data and Pair Selection

- Then we construct four sets of QSO-galaxy samples by intercrossing them, in which a QSO is projected within 200 kpc from a galaxy:

  I 4572 pairs for QSO-nearby galaxies

  II 3216 pairs for QSO-active nearby galaxies

  III 1129 pairs for bright QSO-nearby galaxies

  IV 791 pairs for bright QSO-active nearby galaxies

- When there is more than one galaxy within the 200 kpc projected distance limit of the QSO, we take the closest galaxy in projected distance to make up the pair.

No periodicity in log(1+z) of QSOs in

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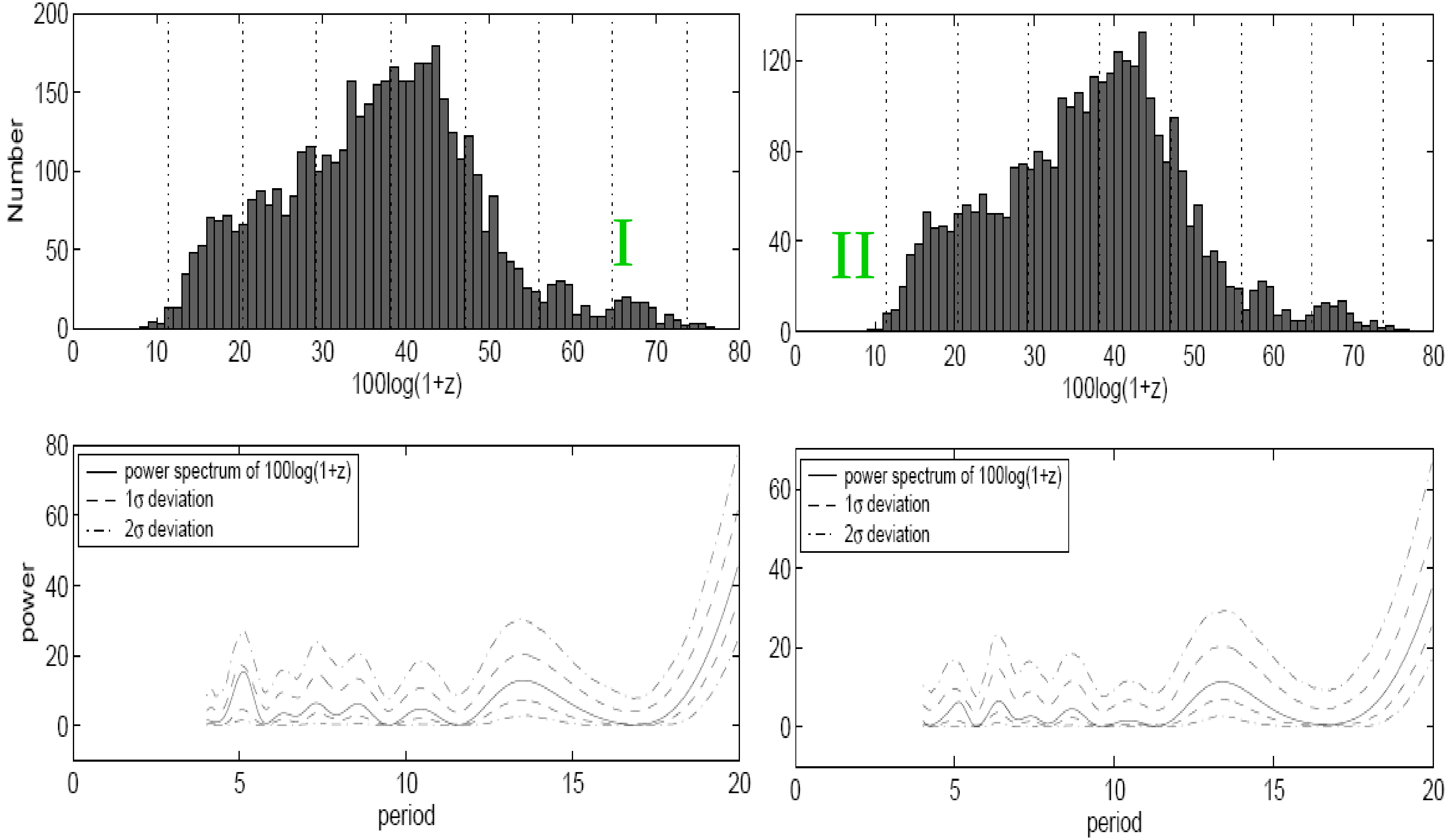
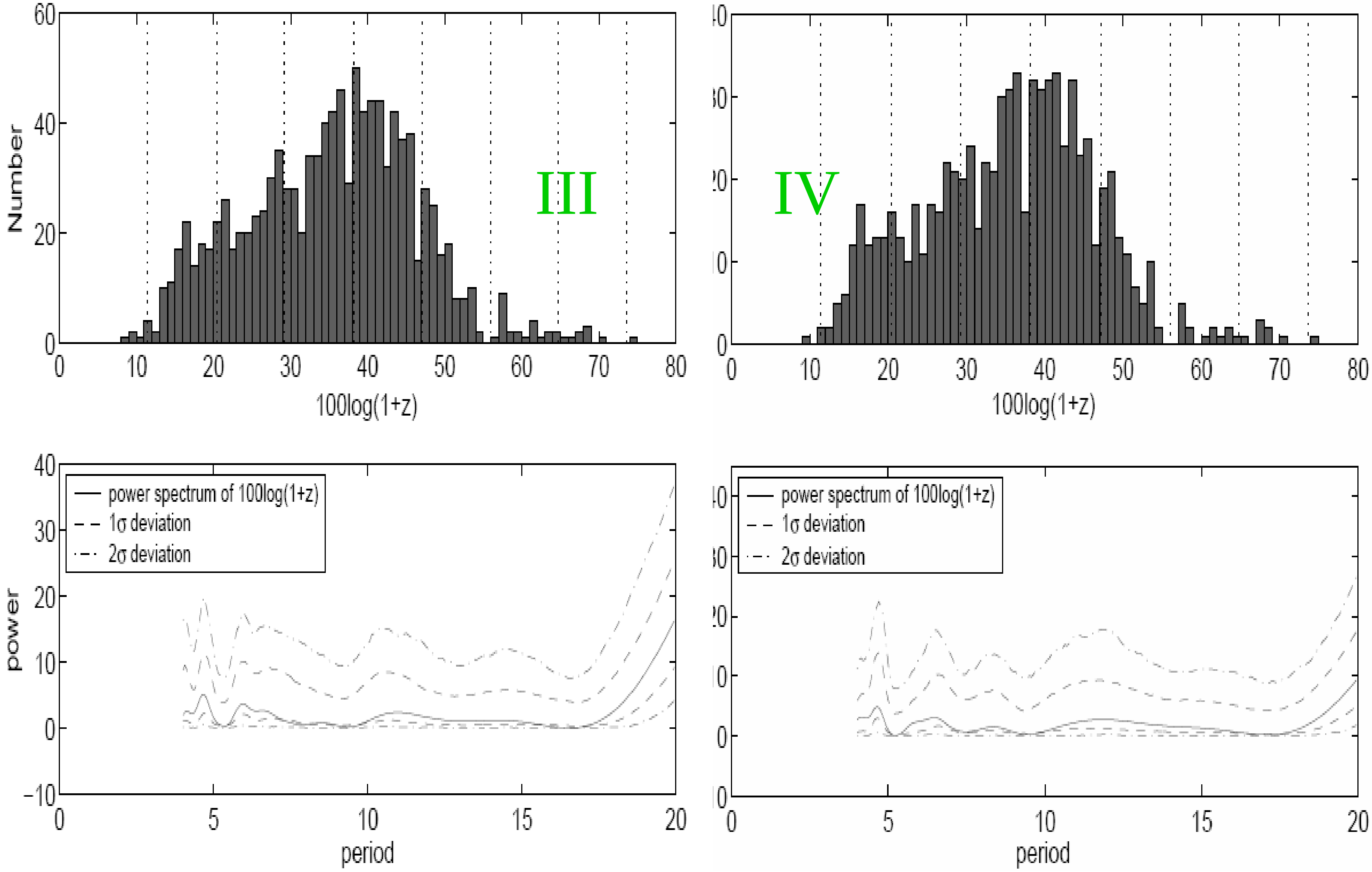
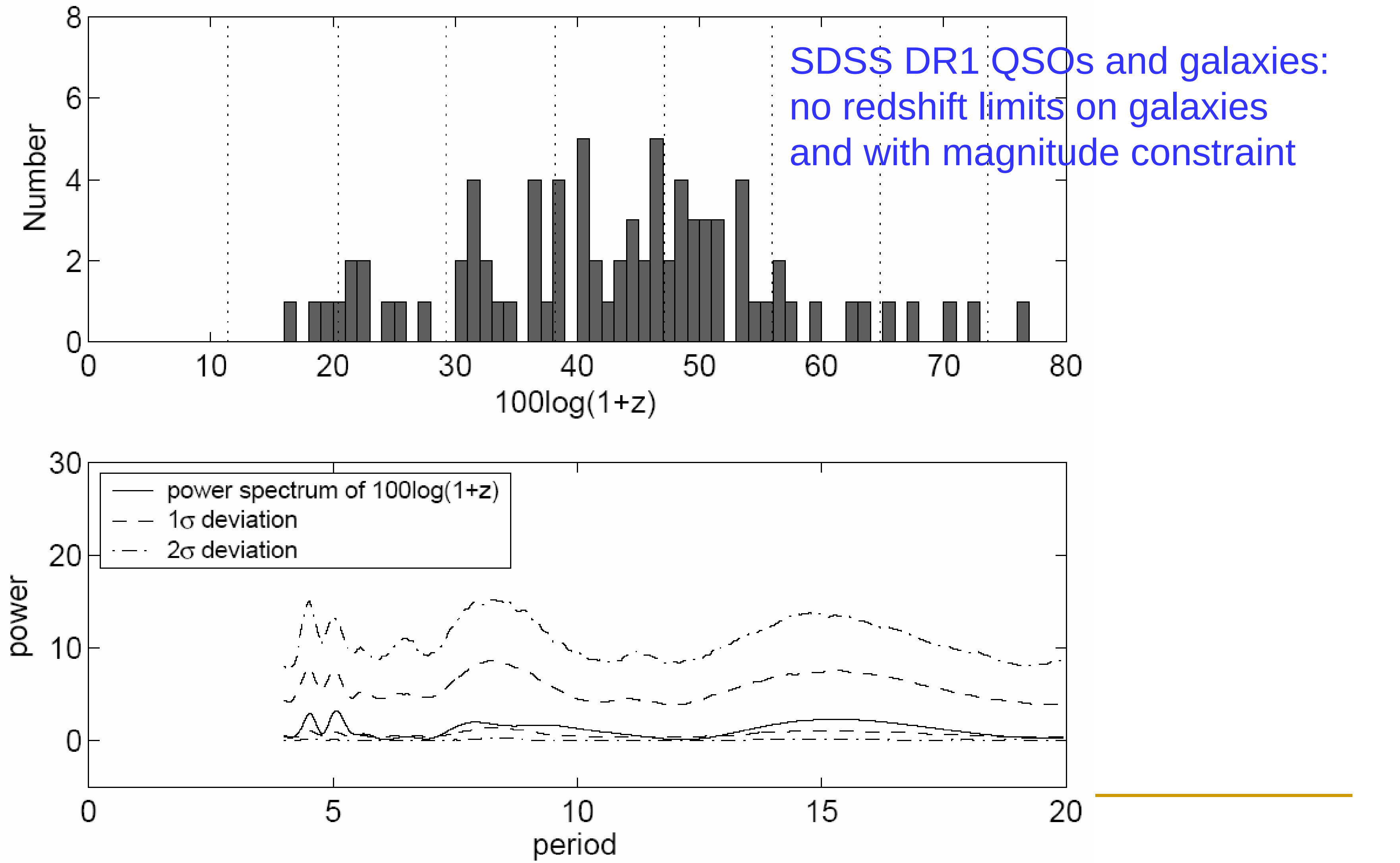


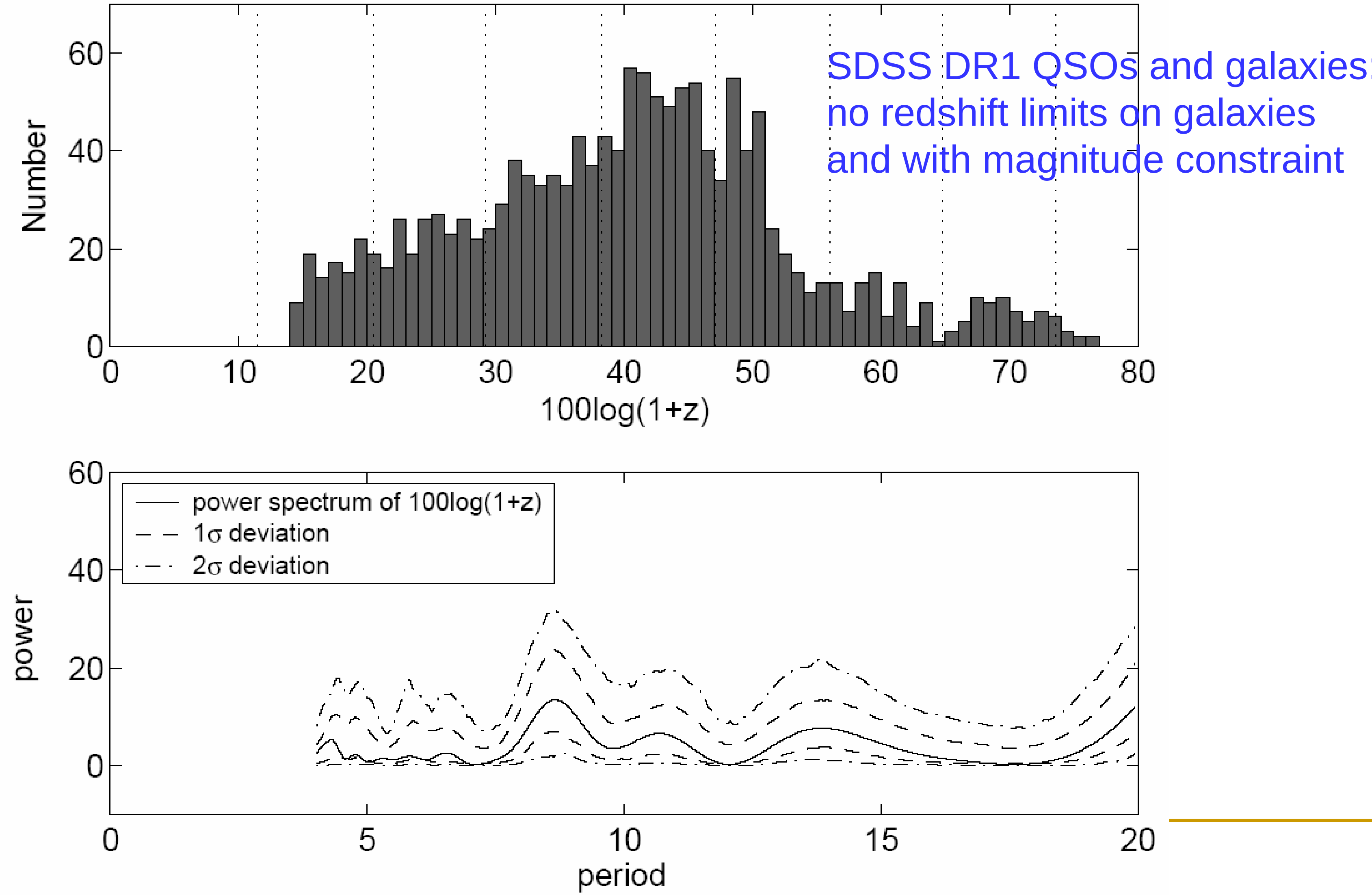
No periodicity in log(1+z) of QSOs in



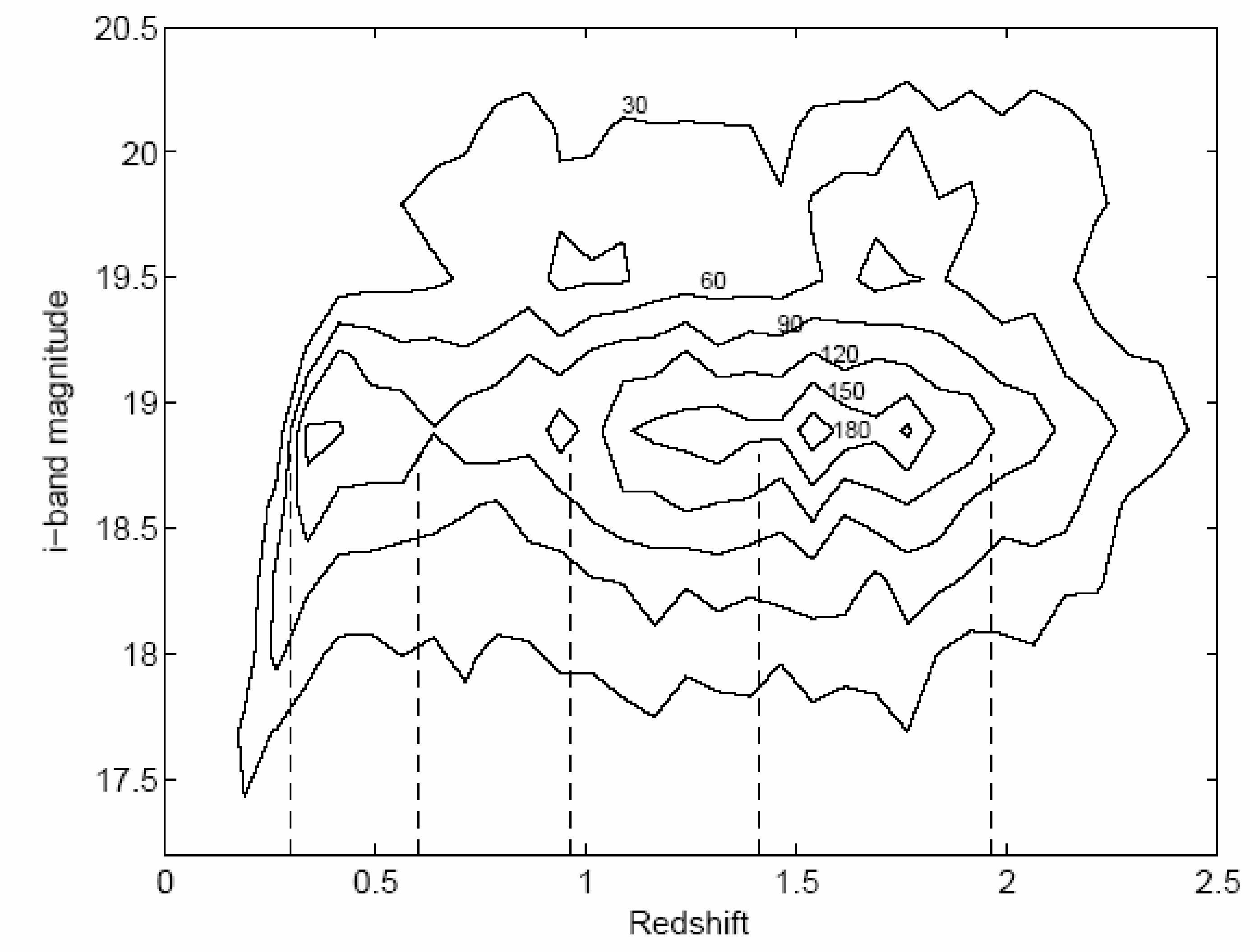
No periodicity in log(1+z) of QSOs in pair: 82 QSOs with *i*(QSO)-*i*(galaxy) > 5



No periodicity in log(1+z) of QSOs in pair: 1459 QSOs with *i*(QSO)-*i*(galaxy) > 3

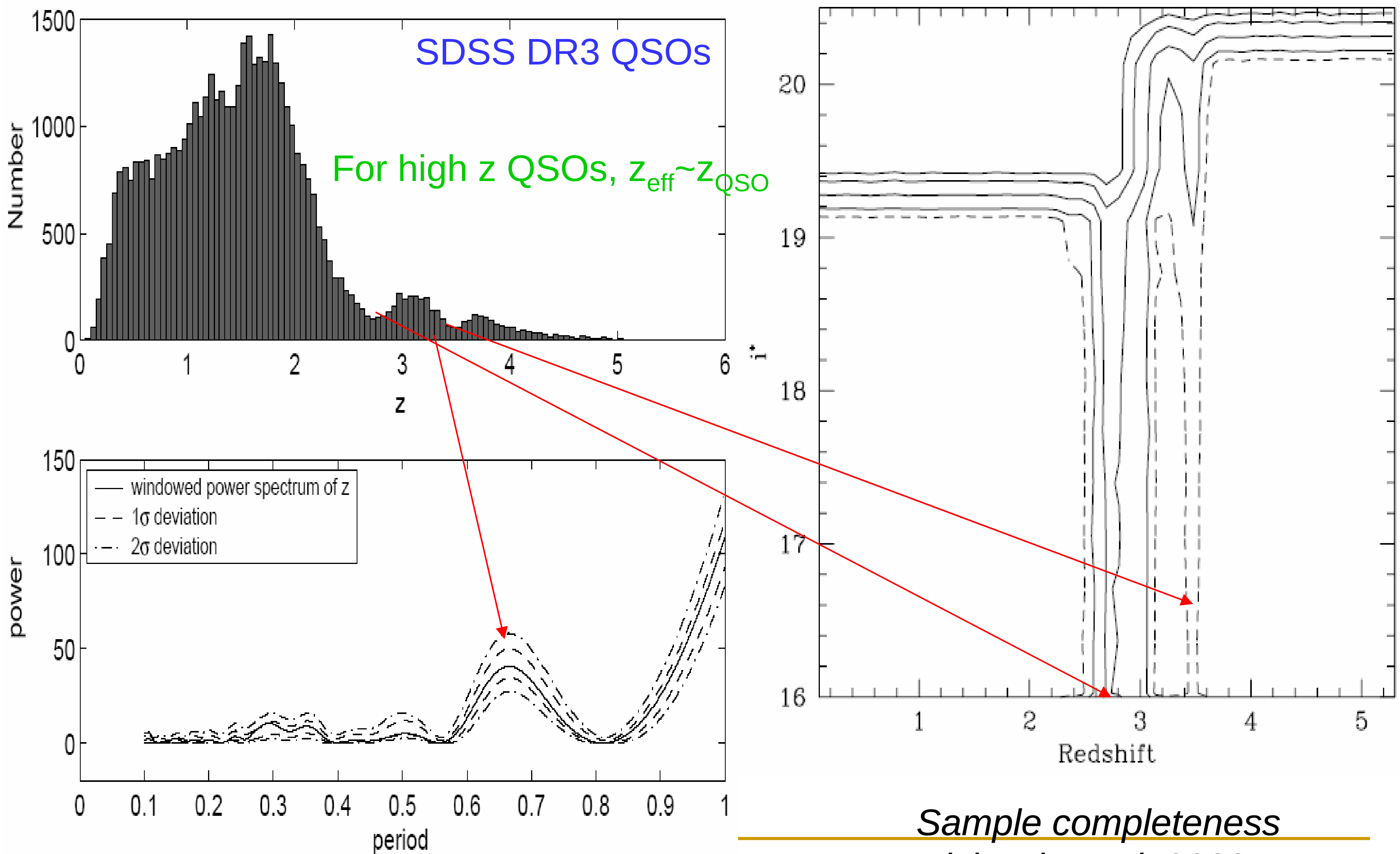


No periodicity in log(1+z) in SDSS DR1 QSOs:



The predicted Karlsson peaks do not exist.

Periodicity in z or selection effects?

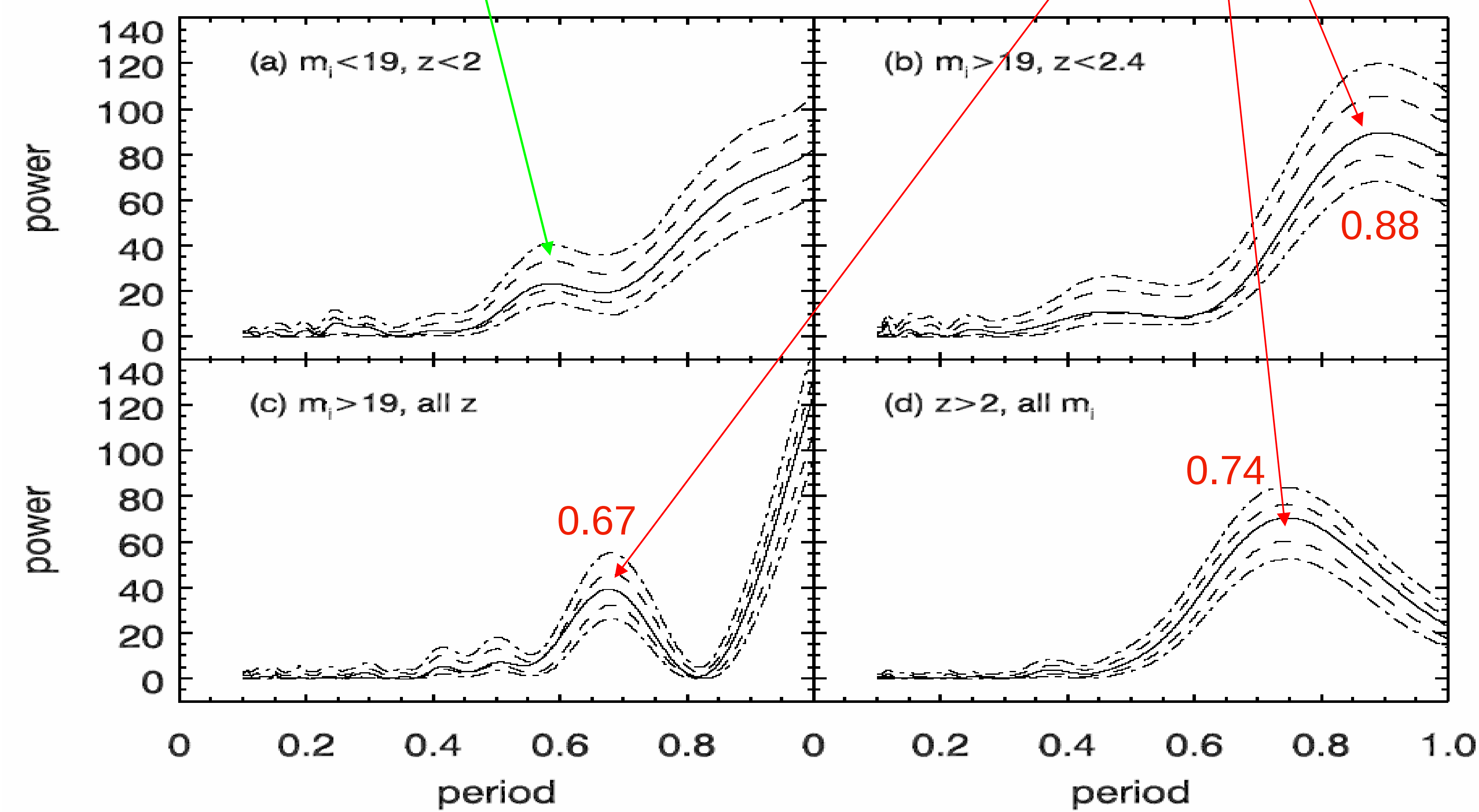


Sample completeness
Richards et al. 2002

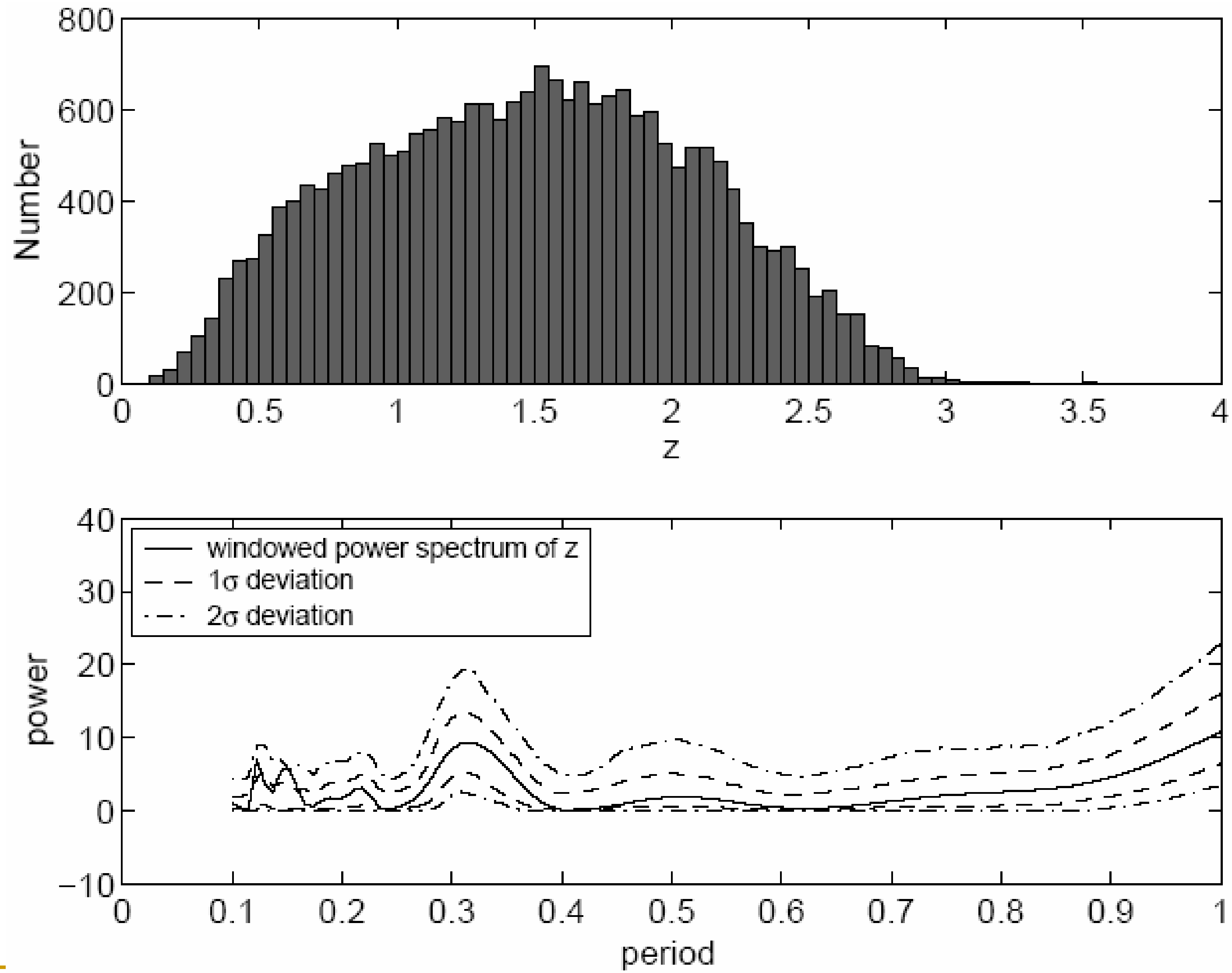
Selection effects:

different peaks in different low-completeness samples

No periodicity in high-completeness sub-sample:
consistent with a continuously ascending curve due to the low frequency component of the redshift distribution



For QSOs with highest quality flag in 2dF

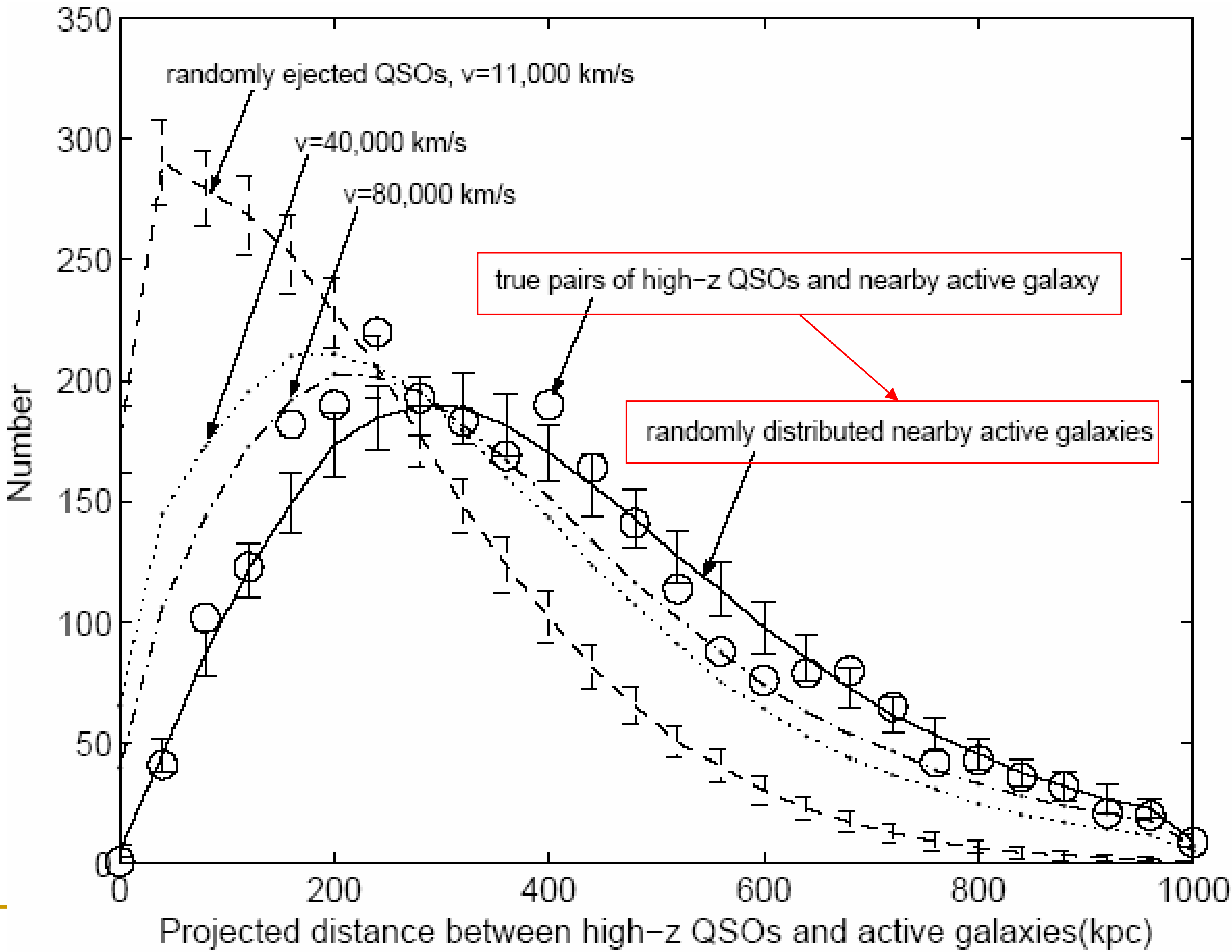


No significant periodicity peak in z

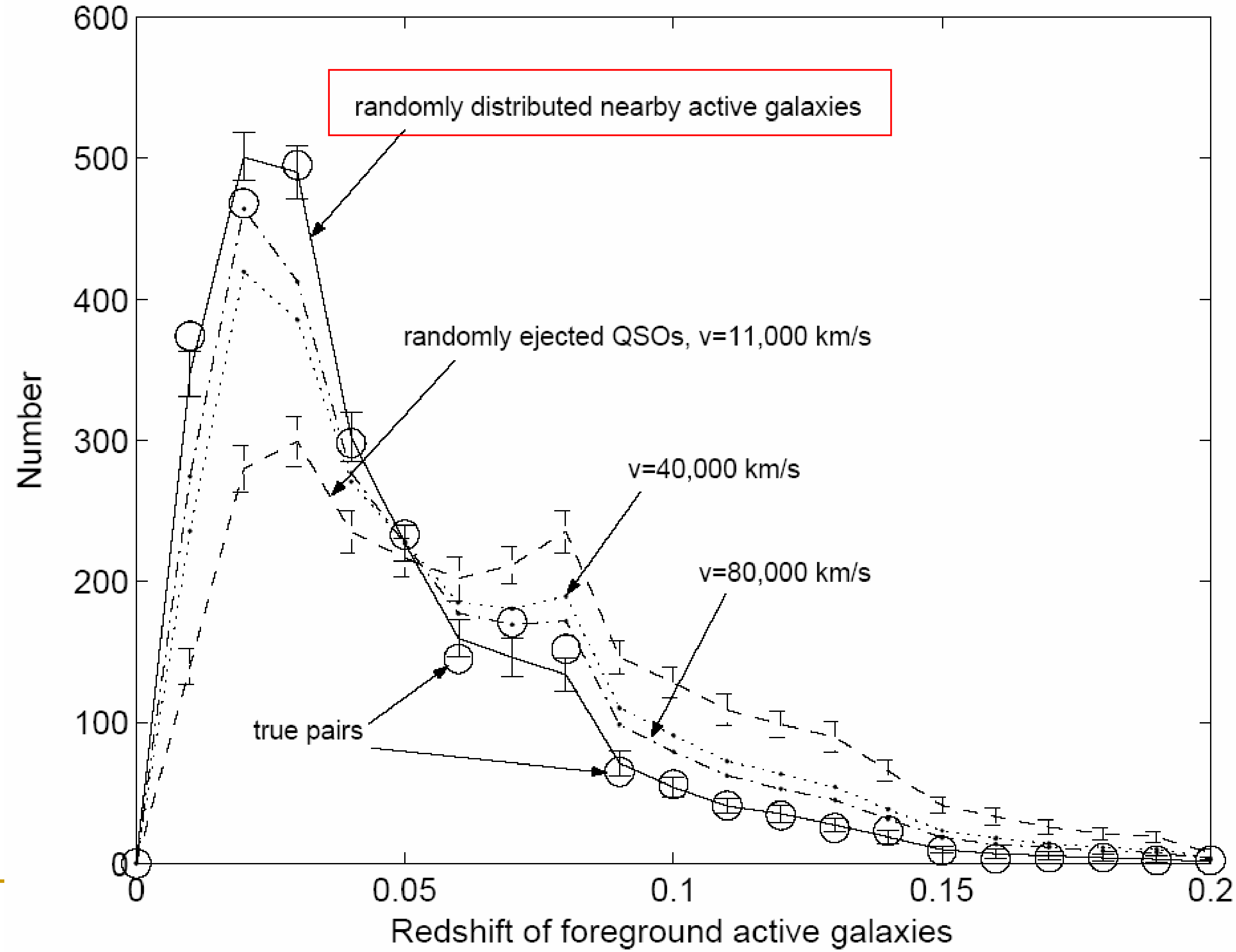
No strong connection between active galaxies and Bell's high-z QSO

- In Bell (2004), a high-z QSO sample from SDSS was presented and the dips at z=2.7 and 3.5 were claimed to come from the intrinsic redshift broadening which is in favor of the DIR model.
  - Derived mean ejection velocity v~11,000 km/s
- To test this hypothesis, we examine the relationship between 2691 QSOs with 2.4<z<4.8 and 77426 nearby active galaxies with 0.01<z<0.2 from NYU-VAGC, all of which have the highest plate quality
  - Test the distribution of projected separation distance between QSOs and active galaxies
  - Test redshift distribution of active galaxies in pairs with QSOs.

Test on distribution of projected distances



Test on distribution of redshift of foreground active galaxies



Discussion

- Due to survey strategies and instrumental limitations, selections of galaxies and QSOs are not entirely independent, and the selection of QSOs in SDSS is also dependent on z:

  55’’ fiber constraint in SDSS

  Different magnitude limits for galaxies and QSOs

  Completeness of spectroscopic selection depends on redshift

- Wrong-pairing when there is more than one galaxy within the projected distance limit:

  when the distance limit is 200 kpc, for majority of paired QSOs (>73%), only one galaxy within the given projected distance

- A lower limit of z=0.01 set for galaxies and magnitude relation in eject galaxies and their off-spring QSOs?

  Result unchanged

Conclusion

- Using samples from SDSS and 2dF, we have demonstrated that

  I. No periodicity at the predicted frequency in log(1 + z) and z, or at any other frequency

  II. No strong connection between foreground active galaxies and high redshift QSOs

- These results support the hypothesis that QSOs are NOT ejected from active galaxies.

Thus QSOs are NOT physically associated with nearby galaxies.